**Anti-Satellite Weapon**

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RIM-161 Standard Missile 3 launched from the US Navy USS *Lake Erie* *Ticonderoga* class cruiser, 2005.

**Anti-satellite weapons** (**ASAT**) are designed to incapacitate or destroy satellites for strategic military purposes. Currently, only the United States, the former USSR (now Russia) and the People's Republic of China are known to have developed these weapons. On September 13, 1985, the United States destroyed US satellite P78-1 using an ASM-135 ASAT anti-satellite missile. On January 11, 2007, China destroyed an old Chinese orbiting weather satellite. A year and a month later, USA destroyed a malfunctioning US spy satellite USA-193 using a RIM-161 Standard Missile 3 on February 21, 2008.

**History**

The development and design of anti-satellite weapons has followed a number of paths. The initial efforts by the USA and the USSR were using ground-launched missiles from the 1950s; many more exotic proposals came afterwards.

**US programs**



U.S. ASM-135 ASAT missile



U.S. Vought ASM-135 ASAT missile launch on Sep. 13, 1985

In the late 1950s the US Air Force started a series of advanced strategic missile projects under the designation **Weapon System WS-199A**. One of the projects studied under the 199A umbrella was Martin's *Bold Orion* air-launched ballistic missile (ALBM) for the B-47 Stratojet, based on the rocket motor from the Sergeant missile. Twelve test launches were carried out between 26 May 1958 and 13 October 1959, but these were generally unsuccessful and further work as an ALBM ended. The system was then modified with the addition of an Altair upper stage to create an anti-satellite weapon with a 1100-mile (1700-km) range. Only one test flight of the anti-satellite mission was carried out, making a mock attack on the Explorer 6 at an altitude of 156 miles (251 km). To record its flight path, the *Bold Orion* transmitted telemetry to the ground, ejected flares to aid visual tracking, and was continuously tracked by radar. The missile successfully passed within 4 miles (6.4 km) of the satellite, which would be suitable for use with a nuclear weapon, but useless for conventional warheads.

A similar project carried out under 199A, Lockheed's *High Virgo*, was initially another ALBM for the B-58 Hustler, likewise based on the Sergeant. It too was adapted for the anti-satellite role, and made an attempted intercept on Explorer 5 on 22 September 1959. However, shortly after launch communications with the missile were lost and the camera packs could not be recovered to see if the test was successful. In any event, work on the WS-199 projects ended with the start of the AGM-48 Skybolt project. Simultaneous U.S. Navy projects were also abandoned although smaller projects did drag on until the early 1970s.

The use of high altitude nuclear explosions to destroy satellites was considered after the tests of the first conventional missile systems in the 1960s. During the Hardtack Teak test in 1958 observers noted the damaging effects of the electromagnetic pulse (EMP) caused by the explosions on electronic equipment, and during the Starfish Prime test in 1962 the EMP from a 1.4 Mt warhead detonated over the Pacific damaged three satellites and also disrupted power transmission and communications across the Pacific. Further testing of weapons effects was carried out under the DOMINIC I series. An adapted version of the nuclear armed Nike Zeus was used for an ASAT from 1962. Codenamed *Mudflap*, the missile was designated DM-15S and a single missile was deployed at the Kwajalein atoll until 1966 when the project was ended in favor of the USAF Thor-based Program 437 ASAT which was operational until 6 March 1975.

Another area of research was into directed energy weapons, including a nuclear-explosion powered X-ray laser proposal developed at Lawrence Livermore National Laboratory (LLNL) in 1968. Other research was based on more conventional lasers or masers and developed to include the idea of a satellite with a fixed laser and a deployable mirror for targeting. LLNL continued to consider more edgy technology but their X-ray laser system development was cancelled in 1977 (although research into X-ray lasers was resurrected during the 1980s as part of the SDI).

ASATs were generally given low priority until 1982, when information about a successful USSR program became widely known in the west. A "crash program" followed, which developed into the Vought ASM-135 ASAT, based on the AGM-69 SRAM with an Altair upper stage. The system was carried on a modified F-15 that carried the missile directly under the central line of the plane. The F-15's guidance system was modified for the mission and provided new directional cueing through the pilot's heads up display, and allowed for mid-course updates via a data link. The first launch of the new anti-satellite missile took place in January 1984. The first, and only, successful interception was on September 13, 1985. The F-15 took off from Edwards Air Force Base, climbed to 80,000 feet (24,384 m) and vertically launched the missile at the Solwind P78-1, a US gamma ray spectroscopy satellite orbiting at 555 km (345 mi), which was launched in 1979. Although successful, the program was cancelled in 1988.

**Soviet Union**



1986 DIA illustration of the IS system attacking a target.

The origins of the Soviet ASAT program are unclear. According to some accounts, Sergei Korolev started some work on the concept in 1956 at his OKB-1, while others attribute the work to Vladimir Chelomei's OKB-52 around 1959. What is certain is that at the beginning of April 1960, Nikita Khrushchev held a meeting at his summer residence in Crimea, discussing an array of defense industry issues. Here, Chelomei outlined his rocket and spacecraft program, and received a go-ahead to start development of the UR-200 rocket, one of its many roles being the launcher for his anti-satellite project. The decision to start work on the weapon was made in March 1961 as the Istrebitel Sputnik (IS) (Interceptor of satellites, or literally "Destroyer of satellites").

The IS system was "co-orbital", approaching its target over time and then exploding a shrapnel warhead close enough to kill it. The missile was launched when a target satellite's ground track rises above the launch site. Once the satellite is detected, the missile is launched into orbit close to the targeted satellite. It takes 90 to 200 minutes (or one to two orbits) for the missile interceptor to get close enough to its target. The missile is guided by an onboard radar. The interceptor, which weighs 1400 kg, may be effective up to one kilometer from a target.

Delays in the UR-200 missile program prompted Chelomei to request R-7 rockets for prototype testing of the IS. Two such tests were carried out on November 1, 1963 and April 12, 1964. Later in the year Khrushchev cancelled the UR-200 in favor of the R-36, forcing the IS to switch to this launcher, whose space launcher version was developed as the Tsyklon 2. Delays in that program led to the introduction of a simpler version, the 2A, which launched its first IS test on October 27, 1967, and a second on April 28, 1968. Further tests carried out against a special target spacecraft, the DS-P1-M, which recorded hits by the IS warhead's shrapnel. A total of 23 launches have been identified as being part of the IS test series. The system was declared operational in February 1973.

Testing resumed in 1976 as a result of the US work on the Space Shuttle. Elements within the Soviet space industry convinced Leonid Brezhnev that the Shuttle was a single-orbit weapon that would be launched from Vandenberg, maneuver to avoid existing anti-ballistic missile sites, bomb Moscow in a first strike, and then land.Although the Soviet military was aware these claims were false, Brezhnev believed them and ordered a resumption of IS testing along with a Shuttle of their own. As part of this work the IS system was expanded to allow attacks at higher altitudes and was declared operational in this new arrangement on July 1, 1979. However, in 1983, Yuri Andropov ended all IS testing and all attempts to resume it failed. Ironically, it was at about this point that the US started its own testing in response to the Soviet program.

The Soviet Union also experimented with large, ground-based ASAT lasers from the 1970s onwards (see Terra-3), with a number of US spysats reportedly being 'blinded' (temporarily) during the 70s and 80s. The USSR had also researched directed energy weapons, under the *Fon* project from 1976, but the technical requirements needed of the high-powered gas dynamic lasers and neutral or charged particle beam systems seemed to be beyond reach. The USSR also experimented with military space stations with a capability for anti-satellite duty in its Almaz program.

In the early 80s, the Soviet Union also started developing a counterpart to the US air-launched ASAT system, using modified MiG-31 'Foxhounds' (at least six of which were completed) as the launch platform.

**ASAT in the era of strategic defense**

The era of the Strategic Defense Initiative (proposed in 1983) focused primarily on the development of systems to defend against nuclear warheads, however, some of the technologies developed may be useful also for anti-satellite use.

After the Soviet Union collapsed, there were proposals to use this aircraft as a launch platform for lofting commercial and science packages into orbit. Recent political developments (see below) may have seen the reactivation of the Russian Air-Launched ASAT program, although there is no confirmation of this as yet.

The Strategic Defense Initiative gave the US and Russian ASAT programs a major boost; ASAT projects were adapted for ABM use and the reverse was also true. The initial US plan was to use the already-developed MHV as the basis for a space based constellation of about 40 platforms deploying up to 1,500 kinetic interceptors. By 1988 the US project had evolved into an extended four stage development. The initial stage would consist of the Brilliant Pebbles defense system, a satellite constellation of 4,600 kinetic interceptors (KE ASAT), of 100 lb (45 kg) each, in Low Earth orbit, and their associated tracking systems. The next stage would deploy the larger platforms and the following phases would include the laser and charged particle beam weapons that would be developed by that time from existing projects such as MIRACL. The first stage was intended to be completed by 2000 at a cost of around $125 billion.

Research in the US and Russia was proving that the requirements, at least for orbital based energy weapon systems, were, with available technology, close to impossible. Nonetheless, the strategic implications of a possible unforeseen breakthrough in technology forced the USSR to initiate massive spending on research in the 12th Five Year Plan, drawing all the various parts of the project together under the control of GUKOS and matching the US proposed deployment date of 2000.

Both countries began to reduce expenditure from 1989 and the Russian Federation unilaterally discontinued all SDI research in 1992. Research and Development (both of ASAT systems and other space based/deployed weapons) has, however, reported to have been resumed under the government of Vladimir Putin as a counter to renewed US Strategic Defense efforts post Anti-Ballistic Missile Treaty. However, the status of these efforts, or indeed how they are being funded through National Reconnaissance Office projects of record, remains unclear. The U.S. has begun working on a number of programs which could be foundational for a space-based ASAT. These programs include the Experimental Spacecraft System (XSS 11), the Near-Field Infrared Experiment (NFIRE), and the space-based interceptor (SBI).

**Recent ASATs**

**China**

Main article: 2007 Chinese anti-satellite missile test



Known orbit planes of Fengyun-1C debris one month after its disintegration by the Chinese ASAT

At 5:28 p.m. EST January 11, 2007, the People's Republic of China successfully destroyed a defunct Chinese weather satellite, FY-1C. The destruction was reportedly carried out by an SC-19 ASAT missile with a kinetic kill warhead similar in concept to the American Exoatmospheric Kill Vehicle. FY-1C was a weather satellite orbiting Earth in polar orbit at an altitude of about 537 miles (865 km), with a mass of about 750 kg (1,650 lb). Launched in 1999, it was the fourth satellite in the Feng Yun series. The missile was launched from a mobile Transporter-Erector-Launcher (TEL) vehicle at Xichang (28°14′49″N 102°01′30″E﻿ / ﻿28.247°N 102.025°E﻿ / 28.247; 102.025) and the warhead destroyed the satellite in a head-on collision at an extremely high relative velocity.

This test raised concerns in some other countries, partly because China did not publicly confirm whether or not the test had occurred until January 23, 2007 but mainly because of fears that it could prompt or accelerate an "arms race" in space. The EU stated that "...a test of an anti-satellite weapon is inconsistent with international efforts to avert an arms race in outer space and undermines security in outer space." These concerns were also reflected in public statements from the governments of the United States, Canada, Australia and Japan. According to CNN, global security analysts stated at the time that the test was most likely aimed at the United States.

**United States**

See also: USA 193 and Operation Burnt Frost



Launch of the SM-3 missile used to destroy USA-193.

USA-193 was an American spy satellite, which was launched on 14 December 2006 by a Delta II rocket, from Vandenberg Air Force Base. It was reported about a month after launch that the satellite had failed. In January 2008, it was noted that the satellite was decaying from orbit at a rate of 1,640 feet (500 m) per day. On 14 February 2008, it was reported that the US Navy had been instructed to fire an SM-3 ABM weapon at it, to act as an anti-satellite weapon.

According to the US Government, the primary reason for destroying the satellite was the approximately 1,000 lb (450 kg) of toxic hydrazine fuel contained on board, which could pose health risks to persons in the immediate vicinity of the crash site should any significant amount survive the re-entry. On February 20, 2008, it was announced that the launch was carried out successfully and an explosion was observed consistent with the destruction of the hydrazine fuel tank.

Experts debated whether the hydrazine tank would have survived an uncontrolled reentry. However, if it had, any human fatality would still have been very unlikely. Although hydrazine is toxic, a small dose would not have been immediately lethal. The chance of the (assumed intact) hydrazine tank landing close enough to at least one person for that person to be killed if he or she lingered in the vicinity of the crash site was about one percent, while the cost of the intercept was about $100 million. Since the satellite was completely uncontrollable, however, the United States chose to set an example of good stewardship of the space domain by taking action to bring the satellite down in a controlled fashion rather than take the risk, the liability for which could have easily exceeded $100 million.

The intercept, however, was widely interpreted as a demonstration of US capabilities in response to the Chinese anti-satellite test a year earlier. The intercept was different from typical ASAT missions in that it took place at a much lower altitude (133 nautical miles or 247 kilometers) than would normally be the case, and the SM-3 missile as currently deployed would not have adequate range and altitude reach for typical ASAT missions in low-Earth orbit. However, the warhead was shown capable of hitting a satellite at orbital closing speeds, and the booster may be upgraded in the future.

**ASAT development**

**India**

See also: CCI-Sat

In a televised press briefing during the 97th Indian Science Congress in Thiruvananthapuram, the DRDO Director General VK Saraswat announced that India was developing lasers and an exo-atmospheric kill vehicle that could be combined to produce a weapon to destroy enemy satellites in orbit. Saraswat also claimed that the "kill vehicle, which is needed for intercepting the satellite, needs to be developed, and that work is going on as part of the ballistic missile defense program". Furthermore, on February 10, 2010, DRDO Director-General and Scientific Advisor to the Defense Minister, Dr VK Saraswat stated that India had "all the building blocks necessary" to integrate an anti-satellite weapon to neutralize hostile satellites in low earth and polar orbits. He said that the propulsion module and kill vehicle already existed in principle on the Agni (missile) series of ballistic missiles, but that India did not have a formal anti-satellite weapon project as yet. He indicated, however, that the anti-satellite weapons could be developed as part of the Indian Ballistic Missile Defense Program, which will complete the development stage in totality by 2014. India had identified development of ASAT weapons "for electronic or physical destruction of satellites in both LEO (2,000-km altitude above earth's surface) and the higher GEO-synchronous orbits" as a thrust area in its long-term integrated perspective plan (2012–2027).

**Russia**

In the early 80s, the Soviet Union used modified MiG-31 'Foxhounds' as a launch platform for an Anti-Satellite weapon system. After the collapse of the Soviet Union, this project was put on hold due to reduced defense expenditures. However, in August 2009, the Russian Air Force had announced the resumption of this program. Further reports in May 2010 based on statements from Col. Eduard Sigalov in Russia's air and space defense forces, indicated that Russia was "developing a fundamentally new weapon that can destroy potential targets in space."